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ON-SITE ADVANCED OCCUPANT PROTECTION SYSTEM INVESTIGATION

CASE NUMBER - IN01-026
LOCATION - Wisconsin
VEHICLE - 2001 HONDA CIVIC LX
CRASH DATE - October 2001

Submitted:
October 29, 2002

Revised:
December 13, 2002

Contract Number: DTNH22-01-C-07002

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
National Center for Statistics and Analysis
Washington, D.C. 20590-0003

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points be coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

Technical Report Documentation Page

1. *Report No.* IN01-026	2. *Government Accession No.*	3. *Recipient's Catalog No.*
4. *Title and Subtitle* On-Site Advanced Occupant Protection System Investigation Vehicle - 2001 Honda Civic LX Location - Wisconsin		5. *Report Date:* October 29, 2002 6. *Performing Organization Code*
7. *Author(s)* Special Crash Investigations Team #2		8. *Performing Organization Report No.* Task #
9. *Performing Organization Name and Address* Transportation Research Center Indiana University 222 West Second Street Bloomington, Indiana 47403-1501		10. *Work Unit No. (TRAIS)* 11. *Contract or Grant No.* DTNH22-01-C-07002
12. *Sponsoring Agency Name and Address* U.S. Department of Transportation (NRD-32) National Highway Traffic Safety Administration National Center for Statistics and Analysis Washington, D.C. 20590-0003		13. *Type of Report and Period Covered* Technical Report Crash Date: October 2001 14. *Sponsoring Agency Code*

15. *Supplementary Notes*
On site investigation involving a 2001 Honda Civic equipped with multiple advanced occupant protection systems that ran off road and hit a large tree

16. *Abstract*

The report covers an on-site investigation of air bag deployment crash involving a 2001 Honda Civic that impacted a large tree. This crash is of special interest because the case vehicle was equipped with multiple advanced occupant protection systems and the case vehicle's restrained driver (18-year-old male) and restrained front right passenger (18 year-old-male) did not sustain any police-reported injuries while the case vehicle sustained police-reported "very severe" damage. The case vehicle was traveling east in the eastbound travel lane of a four-lane undivided local road and intended to continue eastbound. The roadway had two lanes in each direction, with unrestricted parking along the curb in both directions. The driver estimated that the case vehicle was probably traveling approximately 48 km.p.h. [30 m.p.h.] just prior to the crash. The driver admitted that he fell asleep. The case vehicle drifted left of center, across the opposing lane, off the left road edge and into the tree plot along the left (north) road edge. The driver did not attempt any avoidance maneuvers. The front of the case vehicle impacted a large tree, causing the case vehicle's driver and front right passenger air bags to deploy and causing the safety belt pretensioners at the two front seat positions to actuate. The case vehicle rotated a few degrees counterclockwise and came to rest with its front end against the tree, its front wheels in the tree plot and its rear wheels in the roadway. The Honda was towed due to disabling damage. The driver and the front right passenger both sustained lacerations on their hips bilaterally from the lap belt webbing and on their outboard shoulder (driver left and passenger right) from the shoulder belt webbing. Both occupants were later taken to a hospital via private car, where they were treated and released.

17. *Key Words* Air Bag Deployment Motor Vehicle Traffic Crash Injury Severity		18. *Distribution Statement* General Public	
19 *Security Classif. (of this report)* Unclassified	20. *Security Classif. (of this page)* Unclassified	21. *No. of Pages* 11	22. *Price* $5,400

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BACKGROUND

IN01-026

This on-site investigation was brought to the NHTSA's attention on December 5, 2001 by NASS/GES sampling activities. This crash involved a 2001 Honda Civic LX. The crash occurred in October 2001, at 4:35 a.m., in Wisconsin and was investigated by the applicable municipal police department. This crash is of special interest because the case vehicle was equipped with multiple advanced occupant protection systems and the case vehicle's restrained driver (18-year-old male) and restrained front right passenger (18 year-old-male) did not sustain any police-reported injuries while the case vehicle sustained police-reported "very severe" damage. This contractor inspected the scene and case vehicle on December 10, 2001 and interviewed the case vehicle driver on December 15, 2001. The occupants of the case vehicle declined to permit access to their medical records. This summary is based on the Police Crash Report, scene and vehicle inspections, the driver interview, occupant kinematic principles and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling east in the eastbound travel lane of a four-lane undivided local road and intended to continue eastbound. The roadway had two lanes in each direction, with unrestricted parking along the curb in both directions. The asphalt roadway was dry, straight and level, it was dark but lighted, there were no adverse atmospheric conditions, the speed limit was 40 km.p.h. [25 m.p.h.], there were no painted lane lines and no traffic controls. The driver estimated that the case vehicle was probably traveling approximately 48 km.p.h. [30 m.p.h.] just prior to the crash. The driver admitted that he fell asleep. The case vehicle drifted left of center, across the opposing lane, off the left road edge and into the tree plot along the left (north) road edge. The driver did not attempt any avoidance maneuvers.

The crash occurred off the left (north) road edge. The front of the case vehicle impacted a large tree, causing the case vehicle's driver and front right passenger air bags to deploy and causing the safety belt pretensioners at the two front seat positions to actuate. The case vehicle rotated a few degrees counterclockwise and came to rest with its front end against the tree, its front wheels in the tree plot and its rear wheels in the roadway. The tree was approximately 41 centimeters [16 inches] in diameter. At the time of the crash, there were raked leaves piled in front of the tree such that the tree did not sustained any significant scarring or other damage.

The case vehicle was a front wheel drive 2001 Honda Civic LX two-door, five passenger coupe (VIN: 1HGEM21521L------). The Honda was equipped with a 1.6 liter I-4 engine, a five-speed manual transmission with a console-mounted shift lever, and was not equipped with anti-lock brakes. The Honda's wheelbase was 262 centimeters [103.1 inches]. The electronic odometer was non-functional at the time of the inspection, but the driver estimated that there were approximately 4,023 kilometers [2,500 miles] on the car. The case vehicle was towed due to disabling damage.

The case vehicle sustained direct damage starting 10 centimeters [3.9 inches] left of center and continuing leftward 40 centimeters, with induced damage across the entire front. The bumper cover was cracked and torn. The engine hood was bent down at the front, upward in the middle

and was displaced rearward such that the back left corner of the hood impacted the lower left corner of the windshield, causing minor cracks. The left front wheel and tire were pushed rearward, against the trailing edge of the fender. The front edge of the left fender was bent inward, with induced buckling down the entire fender. Maximum crush was 53 centimeters [20.9 inches], in the area immediately inboard of the left headlight assembly. The wheelbase was shortened 10 centimeters [3.9 inches] on the left and lengthened 3 centimeters [1.2 inches] on the right. The CDC was determined to be **12-FYEN-3 (0)**. The WinSMASH reconstruction program, barrier algorithm, was used. Based on the case vehicle's measured crush profile, the Total, Longitudinal and Lateral Delta Vs were, respectively: 35 km.p.h [21.7 m.p.h.], -35 km.p.h. [-21.7 m.p.h.] and 0 km.p.h [0 m.p.h.]. These results appear to be reasonable. The crash severity for the case vehicle was moderate (24 to 40 km.p.h [15 to 25 m.p.h.]).

The interior of the case vehicle showed evidence of minor intrusion by the floor and toe pan in the driver's footwell and the lower portion of the left instrument panel. There was scuffing on the right side of the steering column, and the panel that enclosed the under side of the left instrument panel was cracked and displaced. The steering wheel was not deformed and the shear capsules showed no movement. The center console was cracked on both sides and along the seam where it joined the center instrument panel. Various components in the control panel in the center of the instrument panel were displaced. The glove box door showed evidence of contact by the front right passenger but did not come open. The lower left corner of the windshield had minor cracks due to being impacted by the rearward movement of the engine hood. The rear view mirror was knocked off. There was evidence of scuffing from the deploying front right passenger's air bag on the center of the instrument panel, the right A-pillar and the windshield. Both front seat cushions were bent downward, more so on the right, with the right seat cushion showing a heavy friction scuff in the upholstery.

The driver's air bag was located in the steering wheel hub, with module cover flaps in the "H" configuration. The driver's air bag was round, measuring 63 centimeters [24.8 inches] in diameter. It had two tether straps, and two vent ports at the 11 and 1 o'clock positions. There was no damage to the flaps nor the air bag. There was a smudge of mud in the upper right area on the front of the air bag and no other evidence of contact.

The front right passenger's air bag was located in the top of the instrument panel. The module had a large cover panel that was set into the instrument panel, with the flaps well within the margins of the larger cover panel. The upper left corner of the cover panel was slightly displaced. The flaps were approximately rectangular in the "H" configuration and opened by tearing through pre-stressed seams. The front right passenger's air bag was trapezoidal, measuring 49 centimeters [19.3 inches] vertically, 50 centimeters [19.7 inches] horizontally at the top and 46 centimeters [18.1 inches] at the bottom. It had no tether strap, and two vent ports located at the 10 and 2 o'clock positions. There were faint traces of body fluid (saliva?) in the lower right quadrant on the front of the air bag.

According to the manufacturer's literature, the case vehicle's air bag system included dual-threshold deployment sensors and two-stage inflators. At the time of this investigation, the NHTSA was in the process of establishing cooperative agreements with various manufacturers to

obtain access to the data stored in the restraints control module's Event Data Recorder, but cooperation had not yet been established. It was not possible to download or otherwise access the case vehicle's EDR data. The details concerning the air bags' deployment are not known.

The two front seats were fitted with manual, three-point, lap-and-shoulder safety belt systems that were equipped with retractor pretensioners that did actuate. At the time of the inspection, the pretensioners were still firmly locked such that it was not possible to pull the webbing out of the spool. There was substantial slack webbing laying in the seats, indicating that the belts were in use when the pretensioners actuated. Both the left and right D-rings showed loading marks and there were stress marks and frayed edges on the webbing for both safety belts. The interior trim panel covering the right B-pillar was removed and the retractor mechanism was found to be mounted just below the belt line. There was no visible indication that the pretensioner had actuated other than the firmly locked webbing.

The case vehicle's driver (18-year-old male, white, non-Hispanic, 185 centimeters, 82 kilograms [73 inches, 180 pounds]) was restrained by the available manual, three-point, lap-and-shoulder safety belt system. The seat back was upright, the seat track was adjusted at the rearmost position, and the tilt steering wheel was adjusted at the middle position. The driver admitted that he fell asleep and was probably slumped in his seat, but was otherwise seated in a normal driving posture, with his back against the seat back, both hands on the steering wheel, his left foot on the floor and his right foot on the accelerator pedal. The case vehicle drifted off the left road edge in a gentle manner, the driver did not attempt any avoidance maneuvers, and there was no change in the driver's pre-crash posture.

The front of the case vehicle impacted the tree, causing the driver's air bag to deploy and his safety belt pretensioner to actuate. The driver's momentum caused him to move forward and slightly upward, toward the 12 o'clock direction of principal force, but his motion was restricted by the safety belt and the actuation of the pretensioner. His buttocks and thighs loaded the seat cushion, causing the seat cushion frame to bend downward. He encountered the deployed air bag with his face and upper torso. The driver stated that he sustained minor lacerations on both his hips and on his left shoulder/collar bone area from the safety belt webbing. He indicated that his nose felt sore from impacting the air bag, but claimed he did not sustain any specific lesions on his face. The Police Crash Report indicated that he was not injured and no ambulance or other rescue personnel were called to the scene. After the scene was cleared, he was taken to a hospital emergency department in a private car to be checked.

The case vehicle's front right passenger (18-year-old male, white, non-Hispanic, 208 centimeters, 100 kilograms [82 inches, 220 pounds]) was restrained by the available, manual, three-point, lap-and-shoulder safety belt system. His seat back was fully reclined and he was laying back, sleeping. Because he was very tall, he probably had his knees bent. The case vehicle drifted off the left road edge in a gentle manner, the driver did not attempt any avoidance maneuvers and there was no change in the passenger's pre-crash posture.

The front of the case vehicle impacted the tree, causing the passenger's air bag to deploy and his safety belt pretensioner to actuate. The passenger's momentum caused him to more forward

and slightly upward, toward the 12 o'clock direction of force. Because the seat back was fully reclined and the passenger was laying back asleep, the pretensioner's actuation caused the lap belt webbing to grip his hips, holding his buttocks and thighs firmly against the seat cushion. He slid forward, loading the seat cushion, causing a friction scrub in the center of the seat cushion upholstery and causing the seat cushion frame to bend downward. His right knee impacted the glove box door, but he apparently did not sustain any injury as a result of this knee impact. His torso probably pitched upward from his reclined position and he probably encountered the taut shoulder belt and the air bag at the same time. According to the driver, the passenger sustained minor lacerations on his hips and right shoulder from the safety belt webbing. The Police Crash Report indicated that the passenger was not injured and no ambulance or other rescue personnel were called to the scene. After the scene was cleared, the passenger was taken to a hospital emergency department in a private car to be checked.

CRASH CIRCUMSTANCES

The case vehicle was traveling east in the eastbound travel lane of a four-lane undivided local road and intended to continue eastbound. The roadway had two lanes in each direction, with unrestricted parallel parking along the curb in both directions. The asphalt roadway was dry, straight and level, it was dark but lighted, there were no adverse atmospheric conditions, the speed limit was 40 km.p.h. [25 m.p.h.], there were no painted lane lines and no traffic controls. The roadway's width was 11.6 meters [38 feet] from curb to curb. The driver estimated that the case vehicle was probably traveling approximately 48 km.p.h. [30 m.p.h.] just prior to the crash. The driver admitted that he fell asleep. The case vehicle drifted left of center, across the opposing lane, off the left road edge and into the tree plot along the left (north) road edge. The driver did not attempt any avoidance maneuvers.

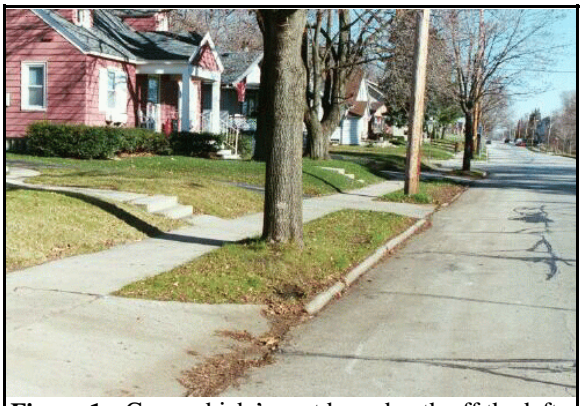

Figure 1: Case vehicle's east bound path off the left road edge and into the tree (case photo #04)

The crash occurred off the left (north) road edge (**Figure 1**). The front of the case vehicle impacted a large tree, causing the case vehicle's driver and front right passenger air bags to deploy and causing the safety belt pretensioners at the two front seat positions to actuate. The case vehicle rotated a few degrees counterclockwise and came to rest with its front end against the tree, its front wheels in the tree plot and its rear wheels in the roadway. The tree was approximately 41 centimeters [16 inches] in diameter. At the time of the crash, there were raked leaves piled in front of the tree such that the tree did not sustained any significant scarring or other damage.

CASE VEHICLE

The case vehicle was a front wheel drive 2001 Honda Civic LX two-door, five passenger coupe (VIN: 1HGEM21521L------). The Honda was equipped with a 1.6 liter I-4 engine, a five-speed manual transmission with a console-mounted shift lever, and was not equipped with anti-

lock brakes. The Honda's wheelbase was 262 centimeters [103.1 inches]. The electronic odometer was non-functional at the time of the inspection, but the driver estimated that there were approximately 4,023 kilometers [2,500 miles] on the car. The case vehicle was towed due to disabling damage.

CASE VEHICLE DAMAGE

The case vehicle sustained direct damage starting 10 centimeters [3.9 inches] left of center and continuing leftward 40 centimeters, with induced damage across the entire front (**Figure 2**). The bumper cover was cracked and torn. The left headlight and turn signal assemblies were shattered and pushed rearward. The engine hood was bent down at the front, upward in the middle and was displaced rearward such that the back left corner of the hood impacted the lower left corner of the windshield, causing minor cracks. The left front wheel and tire were pushed rearward, against the trailing edge of the fender. The front edge of the left fender was bent inward, with induced buckling down the entire fender. Maximum crush was 53 centimeters [20.9 inches], in the area immediately inboard of the left headlight assembly. The wheelbase was shortened 10 centimeters [3.9 inches] on the left and lengthened 3 centimeters [1.2 inches] on the right. The CDC was determined to be **12-FYEN-3 (0)**. The WinSMASH reconstruction program, barrier algorithm, was used. Based on the case vehicle's measured crush profile, the Total, Longitudinal and Lateral Delta Vs were, respectively: 35 km.p.h [21.7 m.p.h.], -35 km.p.h. [-21.7 m.p.h.] and 0 km.p.h [0 m.p.h.]. These results appear to be reasonable. The crash severity for the case vehicle was moderate (24 to 40 km.p.h [15 to 25 m.p.h.]).

Figure 2: Front of case vehicle (case photo #11)

The interior of the case vehicle showed evidence of minor intrusion by the floor and toe pan in the driver's footwell and the lower portion of the left instrument panel. There was scuffing on the right side of the steering column, and the panel that enclosed the under side of the left instrument panel was cracked and displaced. The steering wheel was not deformed and the shear capsules showed no movement. The center console was cracked on both sides and along the seam where it joined the center instrument panel (**Figure 3**). Various components in the control panel in the center of the instrument panel were displaced. The glove box door showed evidence of contact by the front right passenger but did not come open (it was forced open by the police post-crash). The lower left corner of the windshield had minor cracks due to being impacted by

Figure 3: Driver's foot well: minor floor/toe pan intrusion, dislodged lower instrument panel cover and displaced center console (case photo #22)

the rearward movement of the engine hood. The rear view mirror was knocked off. There was evidence of scuffing from the deploying front right passenger's air bag on the center of the instrument panel, the right A-pillar and the windshield. Both front seat cushions were bent downward, more so on the right, with the right seat cushion showing a heavy friction scuff in the upholstery.

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with driver and front right passenger front-impact air bags. The following text concerning 2001 Honda Civic LX air bags is quoted from the supplement to the Honda Owner's Manual entitled "Understanding Your Car's Safety Features".

> Dual-Threshold and Dual-Stage Front Airbags
>
> As you know, car safety equipment is continually being refined to improve occupant protection. Two airbag refinements that have been introduced recently are dual-stage and dual-threshold front airbags. Both are intended to help reduce the chance of airbag-caused injuries in low-speed collisions.
>
> **Dual-threshold airbags** have two deployment thresholds: one for a belted occupant and the other for an unbelted occupant. If the occupant's seat belt is *not* latched, the airbag will deploy at the same threshold (or level of crash severity) as a conventional airbag. But if the seat belt *is latched* -- as it should be -- the airbag will deploy at a slightly higher threshold because, in this situation, the seat belt will provide adequate protection and the airbag would not add any extra help.
>
> **Dual-stage airbags** have inflators with two stages that can be ignited separately or together, depending on crash severity. In a more severe crash, both stages will ignite together. The airbag will inflate rapidly to provide immediate protection, and the inflation force will be the same as with a conventional airbag. In a less severe crash, one stage will ignite first, then the second will ignite a split-second later. As a result, the airbag provides protection for a somewhat longer time and with less inflation force.

At the time of this investigation, the NHTSA was in the process of establishing cooperative agreements with various manufacturers to obtain access to the data stored in the restraints control module's Event Data Recorder, but cooperation had not yet been established. It was not possible to download or otherwise access the case vehicle's EDR data. The details concerning the air bags' deployment are not known, except to note that with the two front safety belt systems being latched and both air bags having deployed, the impact forces apparently exceeded the higher threshold.

The driver's air bag was located in the steering wheel hub, with module cover flaps in the "H" configuration (**Figure 4**). The upper flap was rectangular and measured 8 centimeters [3.1 inches] vertically by 16 centimeters [6.3 inches] horizontally. The lower flap was trapezoidal, measuring 8 centimeters [3.1 inches] vertically, 16 centimeters [6.3 inches] horizontally at the top and 7 centimeters [2.8 inches] at the bottom. The driver's air bag was round, measuring 63 centimeters [24.8 inches] in diameter. It had two tether straps, and two vent ports at the 11 and 1 o'clock positions. There was no damage to the flaps nor the air bag. There was a smudge of mud in the upper right area on the front of the air bag and no other evidence of contact.

Figure 4: Driver's air bag (case photo #40)

The front right passenger's air bag was located in the top of the instrument panel. The module had a large cover panel that was set into the instrument panel, with the flaps well within the margins of the larger cover panel. The upper left corner of the cover panel was slightly displaced. The flaps were approximately rectangular in the "H" configuration and opened by tearing through pre-stressed seams (**Figure 5**). The center seam measured 22 centimeters [8.7 inches]. The upper flap tore 5 centimeters [2.0 inches] on the left and 6 centimeters [2.4 inches] on the right and the lower flap tore 6 centimeters [2.4 inches] on the left and 4 centimeters [1.6 inches] on the right. The front right passenger's air bag was trapezoidal, measuring 49 centimeters [19.3 inches] vertically, 50 centimeters [19.7 inches] horizontally at the top and 46 centimeters [18.1 inches] at the bottom (**Figure 6**). It had no tether strap, and two vent ports located at the 10 and 2 o'clock positions. There were faint traces of body fluid (saliva?) in the lower right quadrant on the front of the air bag.

Figure 5: Front right passenger's air bag cover flap, viewed through the windshield (case photo #45)

Figure 6: Front of front right passenger's air bag (case photo #43)

The two front seats were fitted with manual, three-point, lap-and-shoulder safety belt systems that were equipped with retractor pretensioners that did actuate. At the time of the inspection, the pretensioners were still firmly locked such that it was not possible to pull the webbing out of the spool. There was substantial slack webbing laying in the seats, indicating that the belts were in use when the pretensioners actuated. Both the left and right D-rings showed loading marks and there were stress marks and frayed edges on the webbing for both safety belts. The interior trim panel covering the right B-pillar was removed and the retractor mechanism was found to be mounted just below the belt line. There was no visible indication that the pretensioner had actuated other than the firmly locked webbing.

Figure 7: Front right passenger's safety belt retractor-type pretensioner (case photo #39)

CASE VEHICLE DRIVER

The case vehicle's driver (18-year-old male, white, non-Hispanic, 185 centimeters, 82 kilograms [73 inches, 180 pounds]) was restrained by the available manual, three-point, lap-and-shoulder safety belt system. The seat back was upright, the seat track was adjusted at the rearmost position, and the tilt steering wheel was adjusted at the middle position. The driver admitted that he fell asleep and was probably slumped in his seat, but was otherwise seated in a normal driving posture, with his back against the seat back, both hands on the steering wheel, his left foot on the floor and his right foot on the accelerator pedal. The case vehicle drifted off the left road edge in a gentle manner, the driver did not attempt any avoidance maneuvers, and there was no change in the driver's pre-crash posture.

The front of the case vehicle impacted the tree, causing the driver's air bag to deploy and his safety belt pretensioner to actuate. The driver's momentum caused him to move forward and slightly upward, toward the 12 o'clock direction of principal force, but his motion was restricted by the safety belt and the actuation of the pretensioner. His buttocks and thighs loaded the seat cushion, causing the seat cushion frame to bend downward (**Figure 8**). He encountered the deployed air bag with his face and upper torso. The driver stated that he sustained minor lacerations on both his hips and on his left shoulder/collar bone area from the safety belt webbing. He indicated that his nose felt sore from

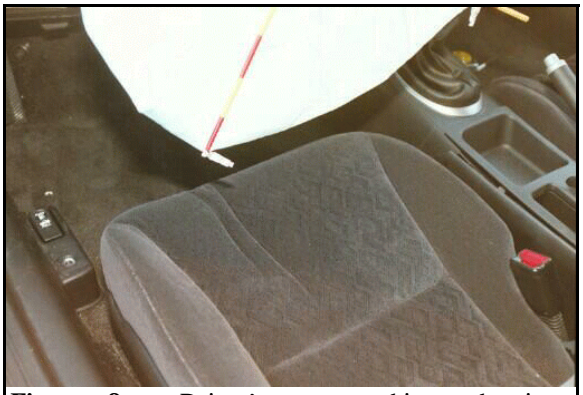

Figure 8: Driver's seat cushion, showing deformation of the cushion; note, there are no longitudinal creases on an undeformed seat (case photo #23)

impacting the air bag, but claimed he did not sustain any specific lesions on his face. The Police Crash Report indicated that he was not injured and no ambulance or other rescue personnel were called to the scene. After the scene was cleared, he was taken to a hospital emergency department in a private car to be checked.

CASE VEHICLE DRIVER INJURIES

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1.	Lacerations, bilateral hips, not further specified (abdomen, inferior)	590600.1 minor	Lap belt webbing	Certain	Interview
2.	Lacerations, left shoulder, not further specified	790600.1 minor	Shoulder belt webbing	Certain	Interview

FRONT RIGHT PASSENGER

The case vehicle's front right passenger (18-year-old male, white, non-Hispanic, 208 centimeters, 100 kilograms [82 inches, 220 pounds]) was restrained by the available, manual, three-point, lap-and-shoulder safety belt system. His seat back was fully reclined and he was laying back, sleeping. Because he was very tall, he probably had his knees bent. The case vehicle drifted off the left road edge in a gentle manner and the driver did not attempt any avoidance maneuvers. There was, thus, no change in the passenger's pre-crash posture.

The front of the case vehicle impacted the tree, causing the passenger's air bag to deploy and his safety belt pretensioner to actuate. The passenger's momentum caused him to move forward and slightly upward, toward the 12 o'clock direction of force. Because the seat back was fully reclined and the passenger was laying back asleep, the pretensioner caused the lap belt webbing to grip his hips, holding his buttocks and thighs firmly against the seat cushion. He slid forward, loading the seat cushion, causing a friction scrub in the center of the seat cushion upholstery and causing the seat cushion frame to bend downward (**Figure 9**). His right knee impacted the glove box door, but he apparently did not sustain any injury as a result of this knee

Figure 9: Front right passenger's seat cushion, showing friction scrub on upholstery and bending of the cushion frame; note, there are no longitudinal creases in an undeformed cushion (case photo #33)

impact. His torso probably pitched upward from his reclined position and he probably encountered the taut shoulder belt and the air bag at the same time. According to the driver, the passenger sustained minor lacerations on his hips and right shoulder from the safety belt. The Police Crash Report indicated that the passenger was not injured and no ambulance or other rescue personnel were called to the scene. After the scene was cleared, the passenger was taken to a hospital emergency department in a private car to be checked.

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1.	Lacerations, bilateral hips, not further specified (abdomen inferior)	590600.1 minor	Lap belt webbing	Certain	Interview
2.	Lacerations, right shoulder, not further specfied	790600.1 minor	Shoulder belt webbing	Certain	Interview

CRASH DIAGRAM IN01-026